Weekly Report

袁媛-2017-11-19

一．　本周完成的事情：

1. 一边做实验室一边慢慢写论文的实验部分
2. 粗略阅读了 **2017-IEEE VIS-A virtual Reality Visualization Tool for Neuron Tracing(**血管那篇文章可能是参考这篇文章考虑做交互式血管抽取**)**

FTLE 实验部分:

1. 上周考虑将粒子移动的 **box** 范围扩大似乎并不需要。
2. 对 **2** 个粒子计算 **FTLE**

实验中出现的问题：

1. 实验中采取在向量场中有向量的地方部署粒子，那么粒子的轨迹至少有 **2** 步，结果中出现却是大多数轨迹只有 **1** 步，需要找出问题
2. 向量场及粒子轨迹获取是计算 **FTLE** 的前一步，但是，由于将温州人口移动的 **box** 拆成了四个方向的向量场，导致单个方向的处理上大片区域向量场为 **0**，粒子移动太稀疏。
3. 实验中粒子的某一步超出了 **box**，使得查不到向量，这里需要加一个筛选
4. 对所有的粒子，用雅可比矩阵计算$\frac{d\phi_{t_0}^{t_0+T}(x)}{dx}|_{x_{i,j}}$ 公式（8），　如何控制循环全局粒子

论文部分：

Notations

4.1 FTLE field

Finite Time Lyapunov exponent field(FTLE) is established in the computation of Lyapunov exponent based on flow field yielded by the population mobility. The FTLE is an asymptotic index measuring the extent to which infinity close particles separate or aggregated in a finite amount of time.

4.1.1 FTLE Formula

Assume that x and y are adjacent particles in initial time, t_0, y=x+$\delta(t_0)$, after T time, the offset distance between them is denoted as:

$$\delta(t_0+\mathrm{T}) = \phi_{t_0}^{t_0+T}(x) - \phi_{t_0}^{t_0+T}(y) = \frac{d\phi_{t_0}^{t_0+T}(x)}{dx}\,\delta(t_0) + \| o(\delta(t_0)) \|^2 \quad (1)$$

where $\| o(\delta(t_0)) \|^2$ can be ignored. Hence, the magnitude of offset distance

$$\| \delta(t_0+\mathrm{T}) \| = \sqrt{\left(\frac{d\phi_{t_0}^{t_0+T}(x)}{dx}\,\delta(t_0), \frac{d\phi_{t_0}^{t_0+T}(x)}{dx}\,\delta(t_0)\right)} = \sqrt{(\delta(t_0), \Delta\delta(t_0))} \quad (2)$$

Where Δ is the Cauchy-Green stress tensor denoted as follows:

$$\Delta = \frac{d\phi_{t_0}^{t_0+T}(x)}{dx}^{*}\frac{d\phi_{t_0}^{t_0+T}(x)}{dx} \quad (3)$$

The maximum offset distance is directly affected by the maximum eigenvalue of

Δ, **that is** $\lambda_{max}(\Delta)$.

$$\text{Max}(\| \delta(t_0 + T) \|) = \sqrt{(\delta(t_0), \lambda_{max}(\Delta)\delta(t_0))} = \sqrt{\lambda_{max}(\Delta)} \| \delta(t_0) \| \quad (4)$$

The formula 4 can be deformated to:

$$e^{ln\sqrt{\lambda_{max}(\Delta)}} \| \delta(t_0) \| = e^{\sigma_{t_0}^{T}|T|} \| \delta(t_0) \| \quad (5)$$

Where $\sigma_{t_0}^{T} = \frac{1}{|T|} \, ln\sqrt{\lambda_{max}(\Delta)}$ **(6)**

Formula 6 is the definition of FTLE, measuring the separate or aggregated conditions of two close particles after finite time T. If $\sigma > 0$, **the two particles are separate to each other. Otherwise, the two particles are aggregated.**

5. 实验过程

5.1 Construction of flow field from trajectory data

5.2 Population mobility-based flow field (????题目再取)

5.2.1 Structured grid （提到粒子的速度插值和轨迹修正）

For the extracted flow field in section 5.1, we lay out particles grid on. For the particles advection on the speed grid, the speed within the grid can be obtained via cube Hermit interpolation.

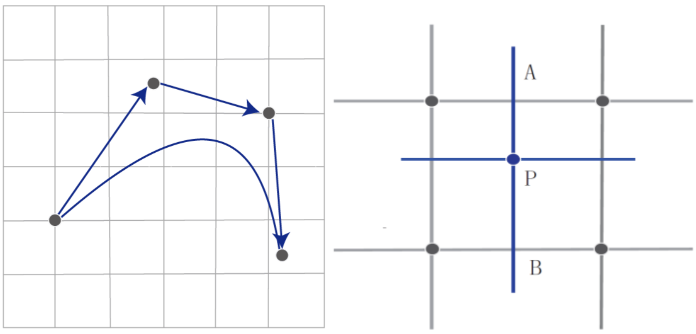

Fig. 1

用 **linear lagrange interpolation** 对网格点内的 **point** 进行插值得到其速度

$$v(x) = v_0\frac{x-x_1}{x_0-x_1} + v_1\frac{x-x_0}{x_1-x_0} \quad (7)$$

If the particle does not arrive accurately on the grid, we adopt linear lagrange interpolation to determine its velocity. We choose adjacent horizontally two grid point to interpolate. Then the velocity in position A,B can easily be obtained. We then interpolate A and B to obtain the velocity of particle P.

5.3 计算轨迹的 FTLE 以及提取 LCS

In section 4.1, the maximum eigenvalue of Δ **can be computed to obtain FTLE.**

In Formula 3,

$$\frac{d\phi_{t_0}^{t_0+T}(x)}{dx}\bigg|_{x_{i,j}} = \begin{bmatrix} \frac{x_{i+1,j}(t+T)-x_{i-1,j}(t+T)}{x_{i+1,j}(t)-x_{i-1,j}(t)} & \frac{x_{i+1,j}(t+T)-x_{i-1,j}(t+T)}{y_{i+1,j}(t)-y_{i-1,j}(t)} \\ \frac{y_{i+1,j}(t+T)-y_{i-1,j}(t+T)}{x_{i+1,j}(t)-x_{i-1,j}(t)} & \frac{y_{i+1,j}(t+T)-y_{i-1,j}(t+T)}{y_{i+1,j}(t)-y_{i-1,j}(t)} \end{bmatrix} \quad (8)$$

二. 下周任务

1. 解决实验中碰到的问题

2. 进行数据处理的同时，将其用 **D3** 在前端页面中展示结果

3. 重新梳理思路